Bundesamt für
Kartographie und Geodäsie

Validation of local ties between SLR and GNSS by using space ties

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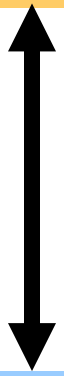
Local ties and space techniques

„Local Tie“:

3D vector between reference points of space geodetic instruments (GNSS antenna or SLR telescope or …) at co-located sites

From terrestrial measurements



Discrepancies ! How to evaluate ?

Station coordinates from space techniques:

3D position of reference points of space geodetic instruments (GNSS antenna or SLR telescope or …)

From space-geodetic measurements

Local ties and space techniques: Validation?

Problem in «classical» combination approach:

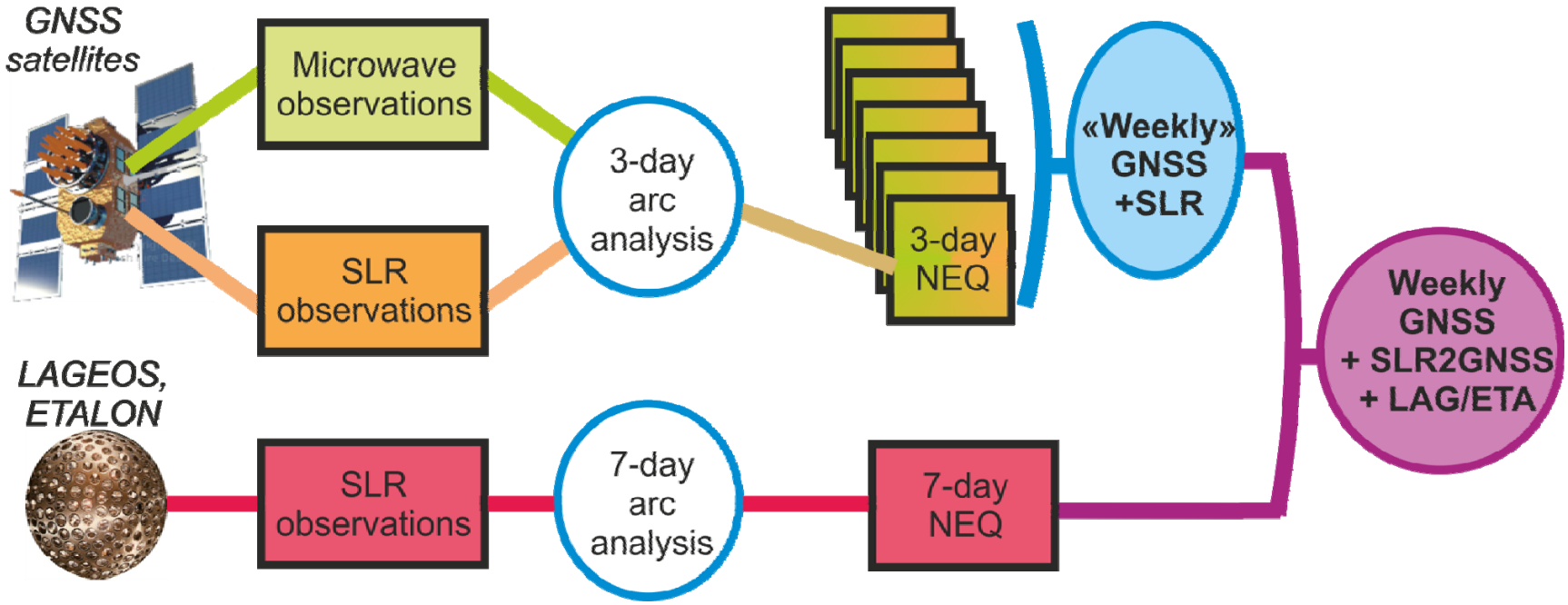
Only ERPs and station coordinates are common parameters

- Station coordinates have to be combined
- At least some Local Ties have to be used to connect the techniques
- An independent validation is NOT possible

Alternatives needed for connecting space geodetic techniques:

Satellites equipped with GNSS and SLR

GNSS-SLR combination: Satellite co-location



- Using co-locations at GNSS satellites for connecting both techniques
- Local Ties are not necessary as additional constraint
- Allowing for an independent comparison

Co-location studies

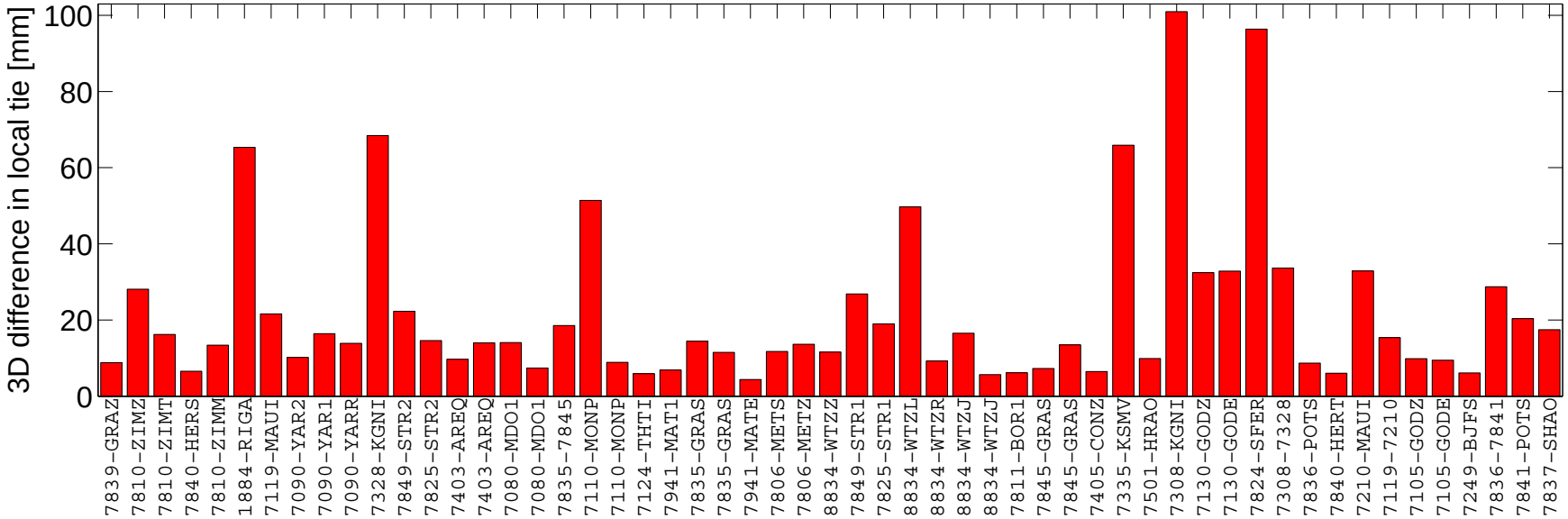
1.) ITRF-like solution

- Accumulated solution 2001.0 – 2011.0
- Estimating station coordinates + velocities
- Introduce discontinuities / split into sub-intervals

2.) Weekly solutions

- „Epoch reference frames“
- How stable is the local tie realized when using satellite co-locations only?

Discrepancies at co-locations

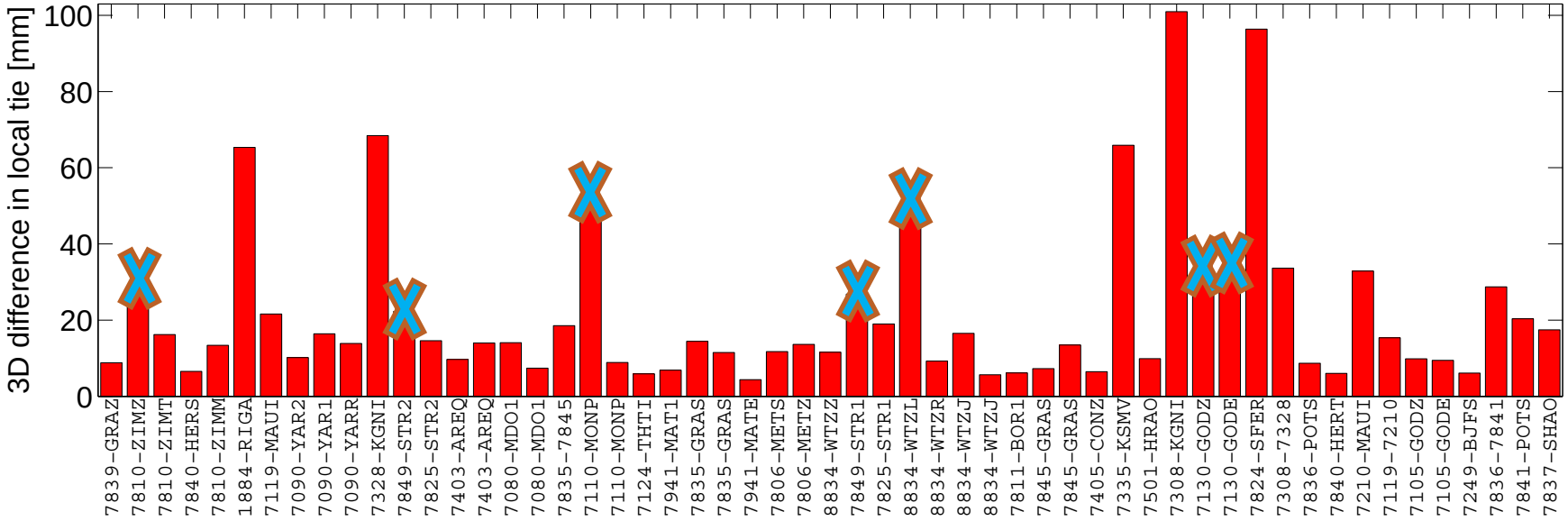


3-D agreement:

$0 \text{ mm} < \Delta \leq 10 \text{ mm}$	17 co-locations
$10 \text{ mm} < \Delta \leq 20 \text{ mm}$	13 co-locations
$20 \text{ mm} < \Delta \leq 30 \text{ mm}$	5 co-locations
$30 \text{ mm} < \Delta$	15 co-locations

Discrepancies at co-locations

X Less than 3 years observation time



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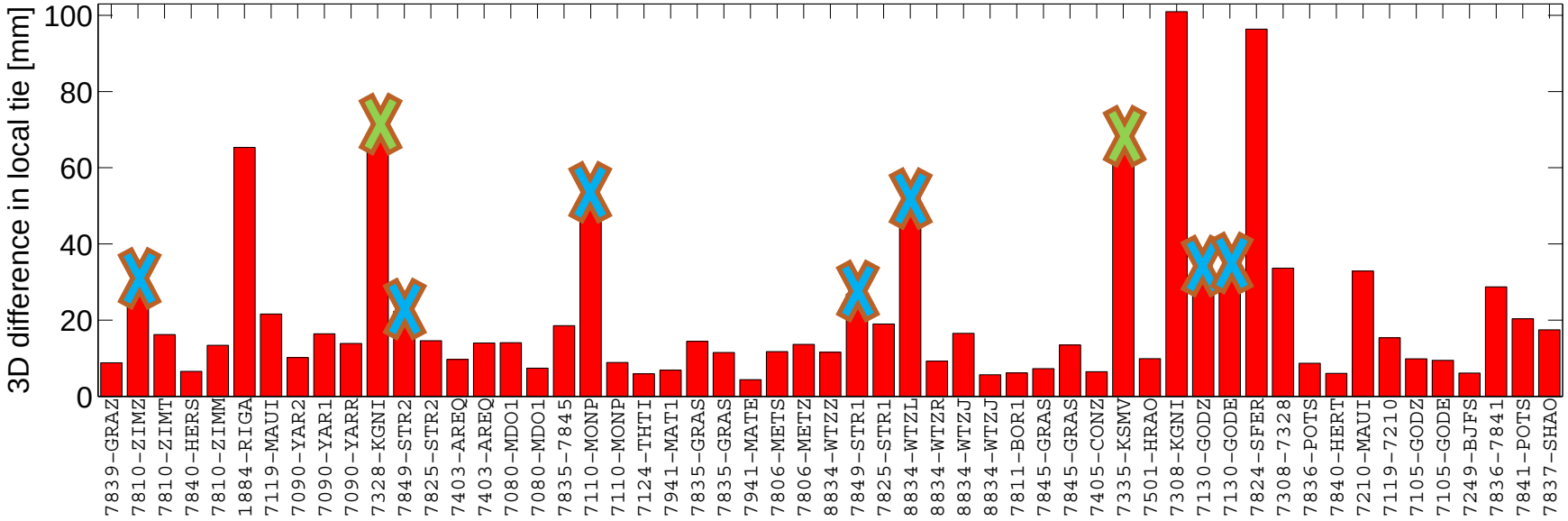
Discrepancies at co-locations

Less than 3 years observation time
GNSS and SLR never in parallel



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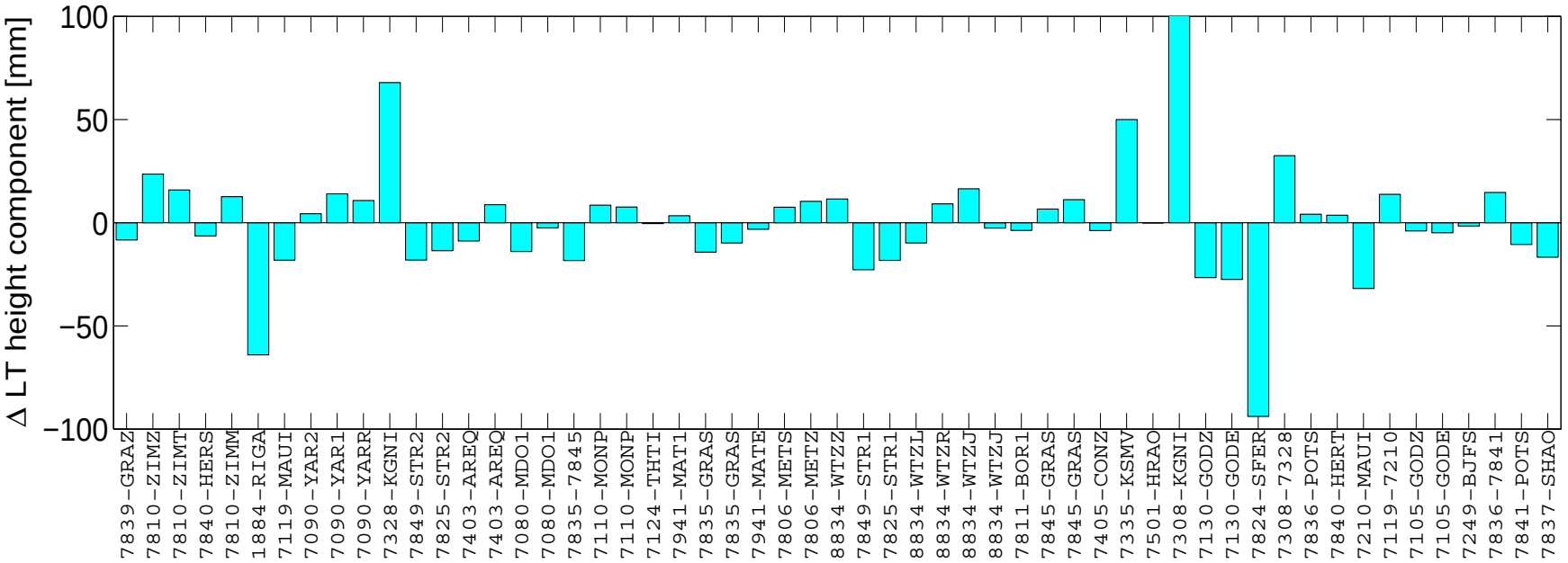

Height agreement:

$0 \text{ mm} < \Delta H \leq 3 \text{ mm}$	5 co-locations
$3 \text{ mm} < \Delta H \leq 5 \text{ mm}$	10 co-locations
$5 \text{ mm} < \Delta H \leq 10 \text{ mm}$	12 co-locations
$10 \text{ mm} < \Delta H \leq 20 \text{ mm}$	20 co-locations
$20 \text{ mm} < \Delta H \leq 30 \text{ mm}$	4 co-locations
$30 \text{ mm} < \Delta H$	10 co-locations

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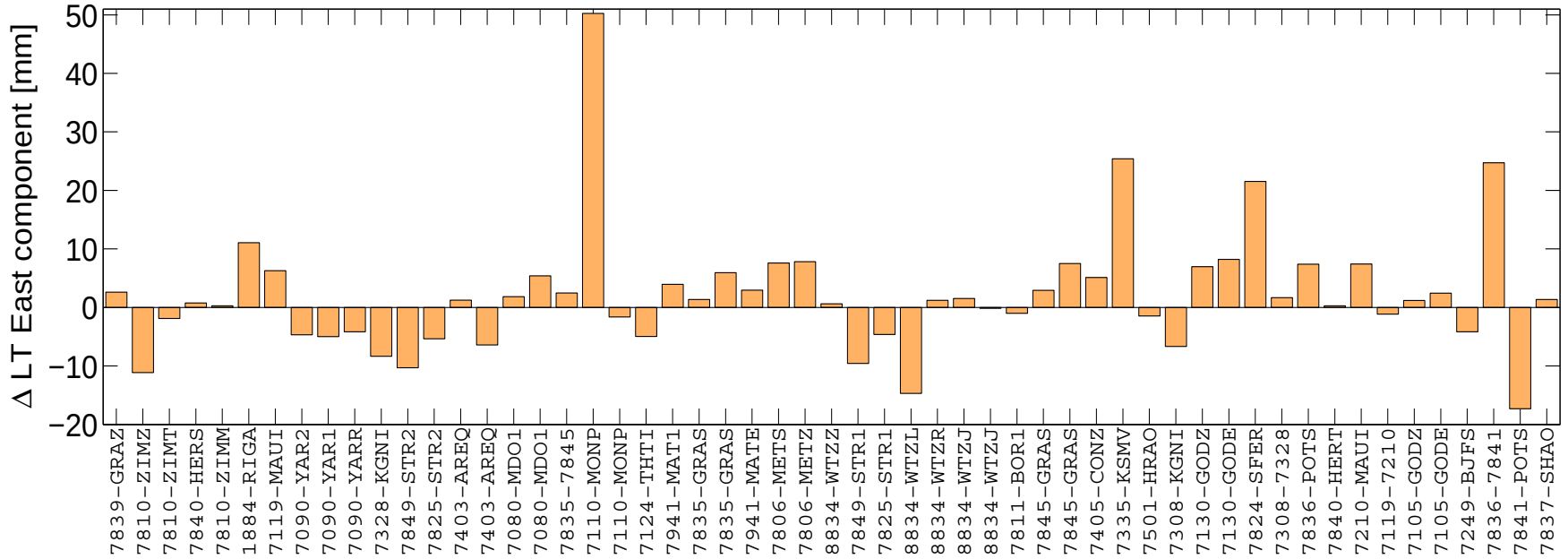
Discrepancies at co-locations

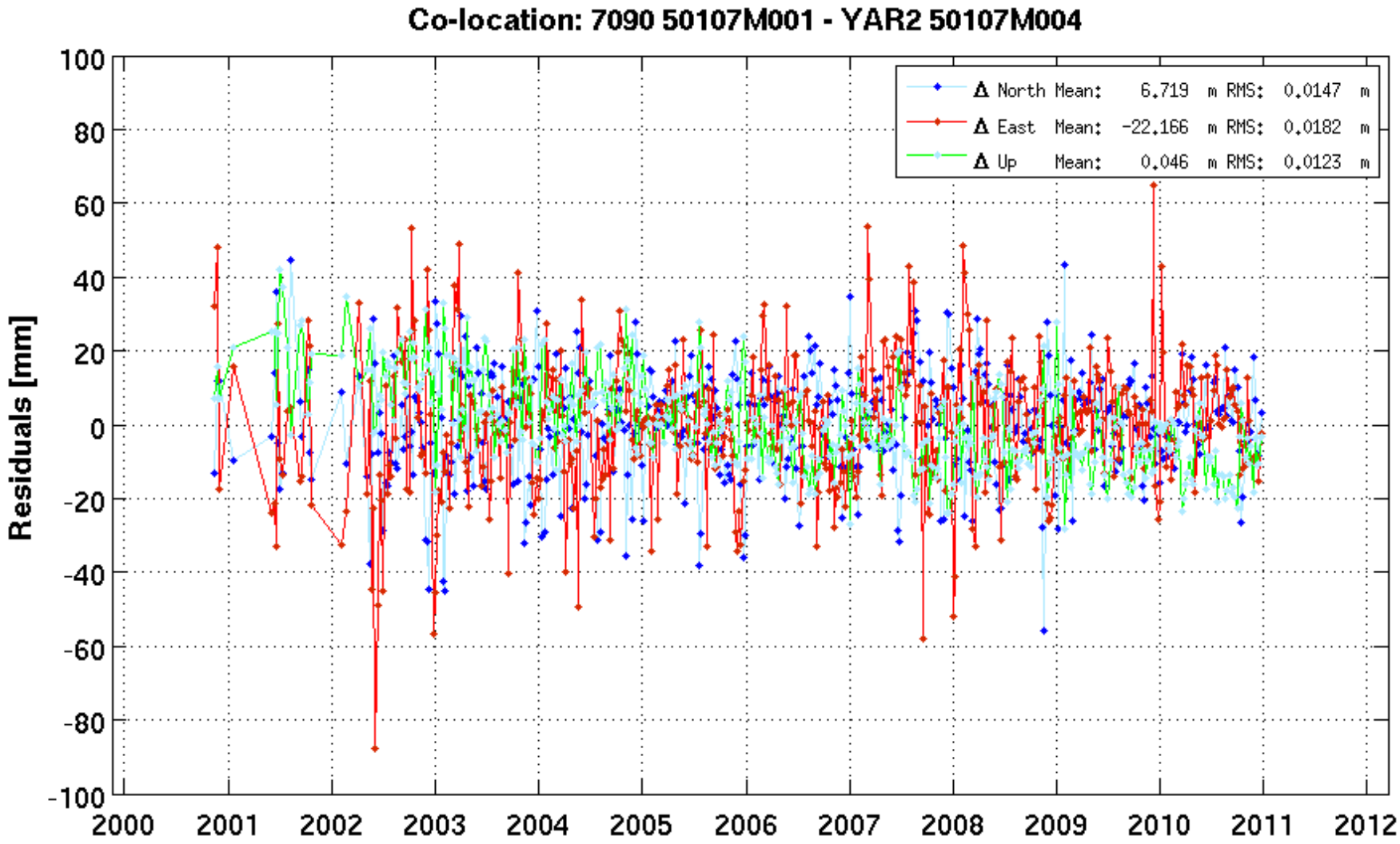


Horizontal agreement:

0 mm < ΔHz ≤ 3 mm	10 co-locations
3 mm < ΔHz ≤ 5 mm	8 co-locations
5 mm < ΔHz ≤ 10 mm	23 co-locations
10 mm < ΔHz ≤ 20 mm	10 co-locations
20 mm < ΔHz ≤ 30 mm	2 co-locations
30 mm < ΔHz	8 co-locations

41

Time series of co-locations



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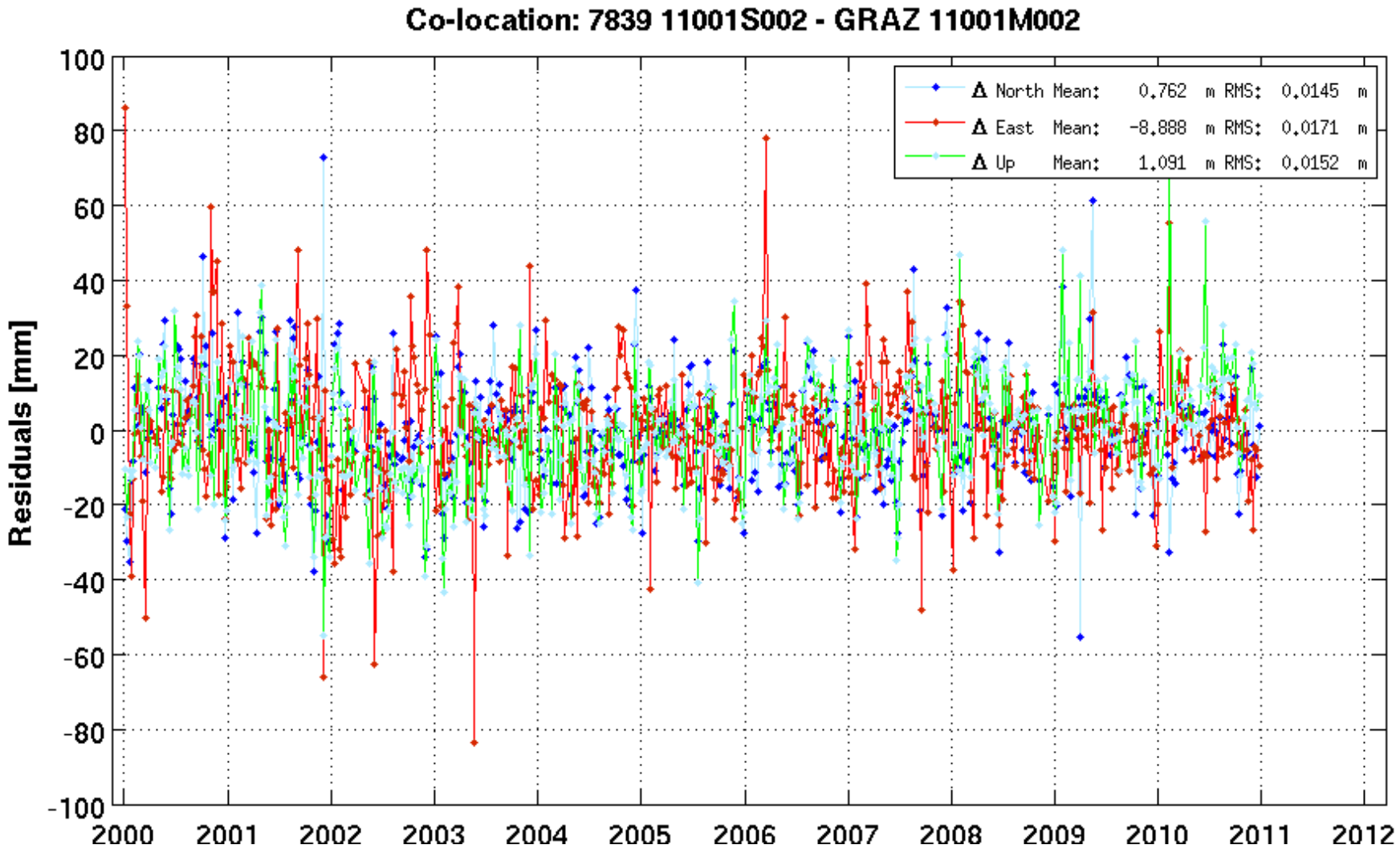

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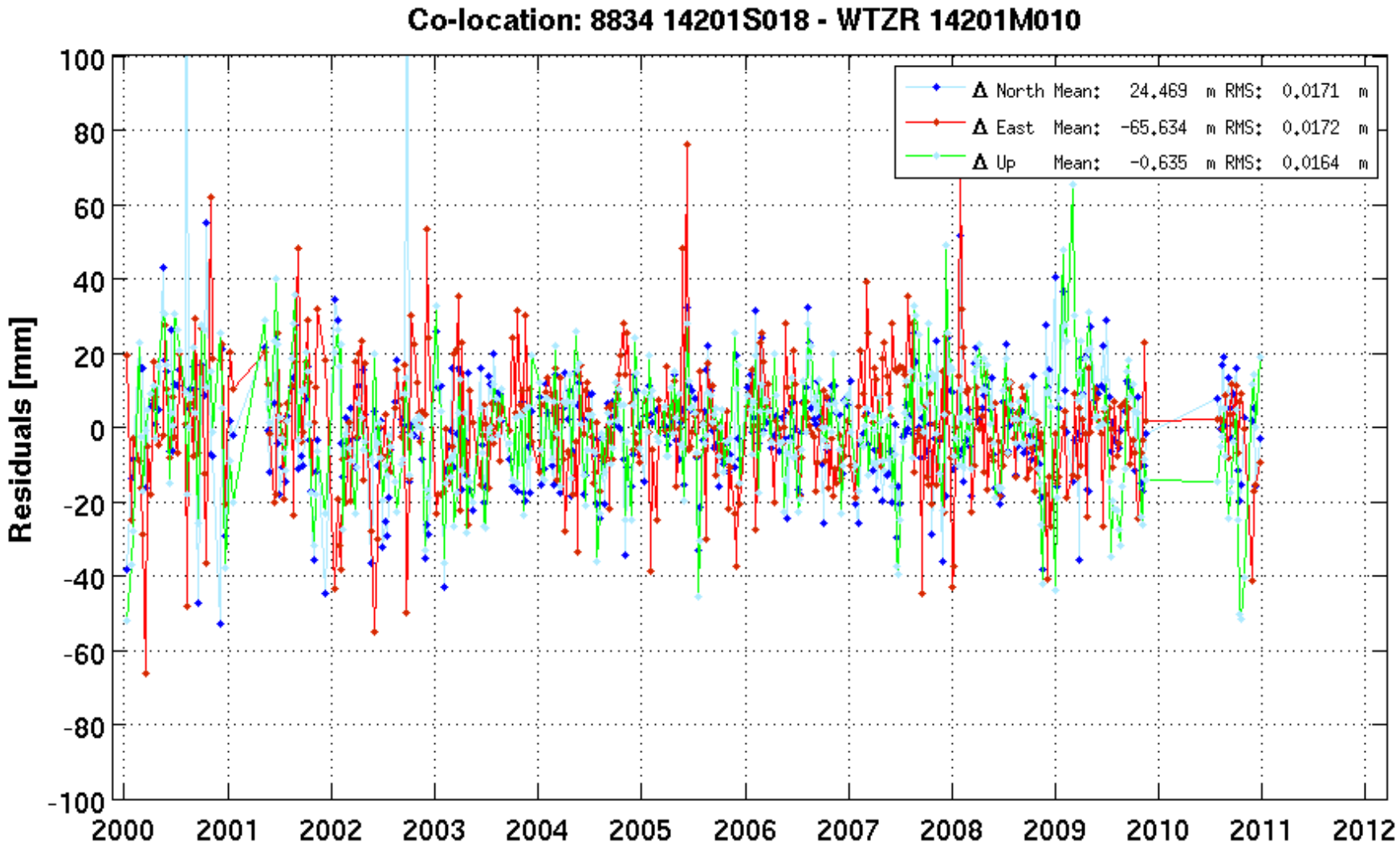

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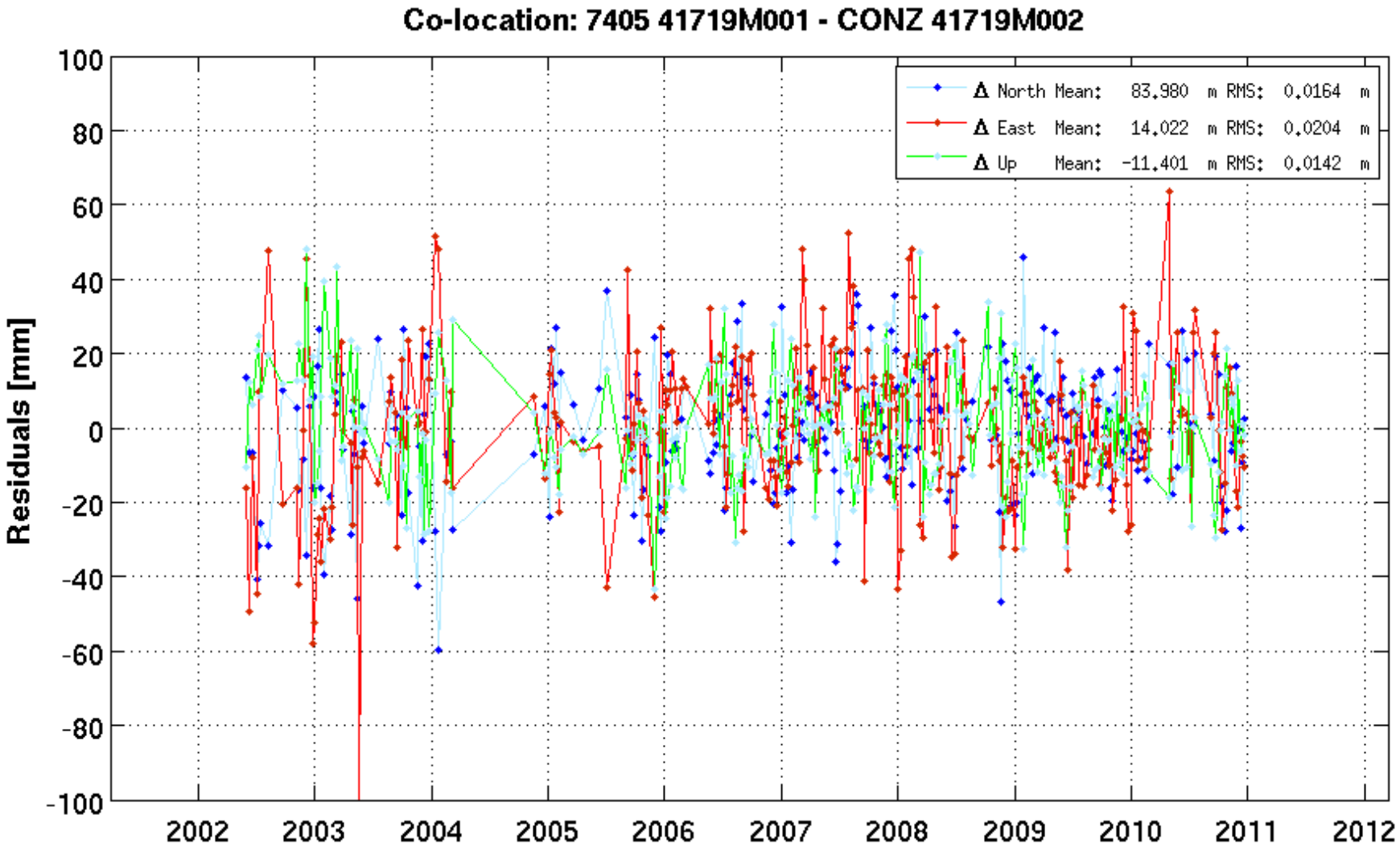
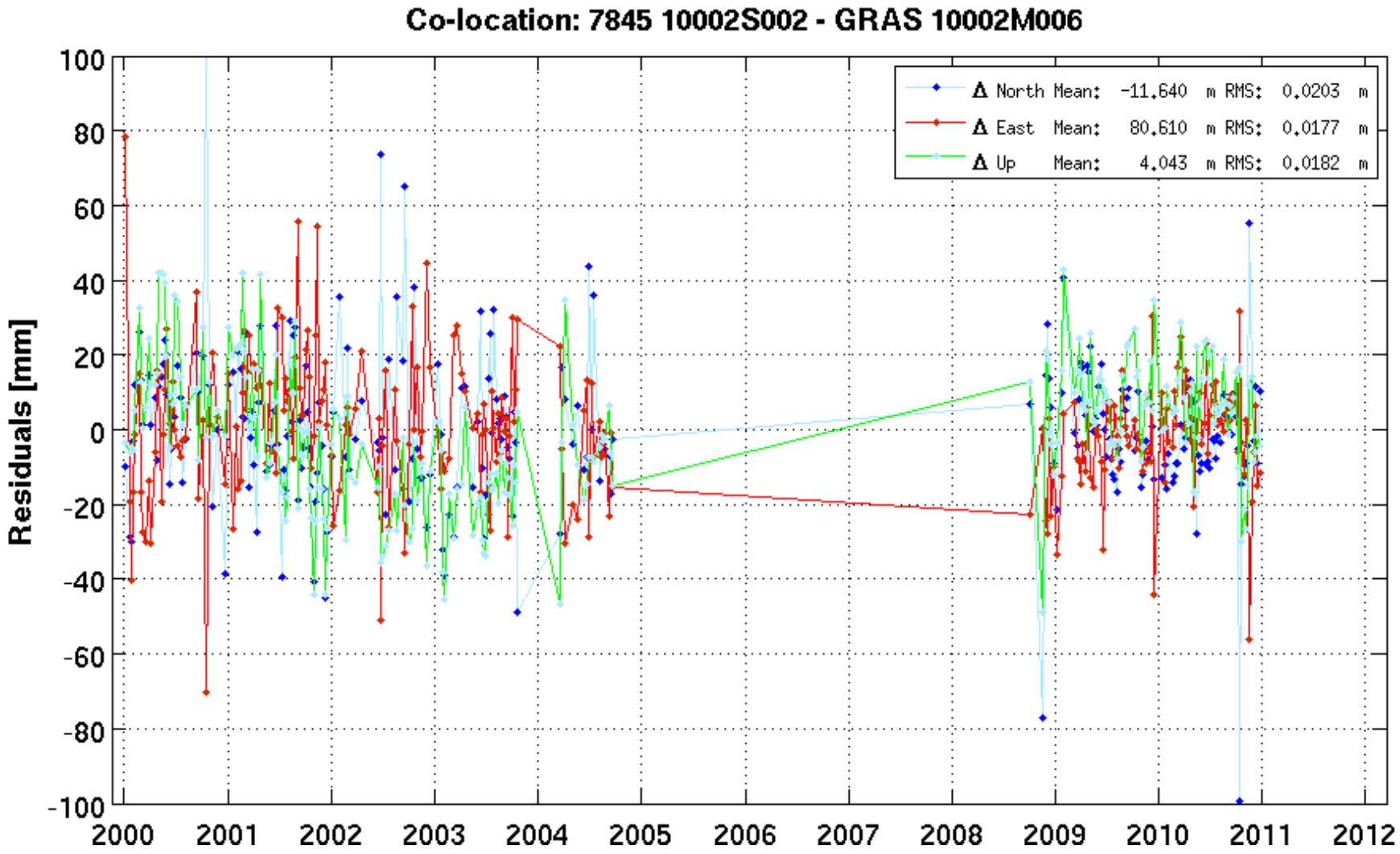


Time series of co-locations



Summary

- GNSS-SLR satellite co-locations provide an alternative combination method
- Useful for **independent** validation of Local Ties
- „ITRF“: Horizontal agreement is better than height agreement (**41 vs. 27 co-locations better than 1 cm**)
- „Epoch reference frame“: **East** component is the weakest
- To be improved:
  - Extend time series (more SLR tracking of GLONASS since 2011)
- **Reason for discrepancies** have to be identified by other methods!